



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**

**REGION 10**

1200 Sixth Avenue  
Seattle, WA 98101

JAN 15 2002

Reply To Attn Of: ECO

Jay Minthorn, Chairman  
Columbia River Inter-Tribal Fish Commission  
729 NE Oregon Street, Suite 200  
Portland, Oregon 97232

Dear Chairman Minthorn:

I am writing to you in response to your letter of September 21, 2001, concerning the efforts of the U.S. Environmental Protection Agency (EPA) to establish Total Maximum Daily Loads (TMDLs) for temperature and dissolved gas in the mainstem Columbia and Snake Rivers. This letter will provide a status report of this TMDL effort, describe EPA's role in this TMDL effort, address the concerns identified in your letter concerning monitoring and system configuration changes, and describe EPA's efforts to consult and coordinate with Columbia Basin Tribes.

**Description of Total Maximum Daily Load Work Efforts**

EPA Region 10 is working with the states of Idaho, Oregon, and Washington, in coordination with 14 Columbia Basin Tribes, to develop mainstem Columbia/Snake River TMDLs for dissolved gas and water temperature. These TMDLs will characterize the sources of Total Dissolved Gas and temperature loadings and allocate those loadings to meet water quality standards established under the federal Clean Water Act.

Through the end of 2002, EPA will be making water quality decisions in five related efforts to establish TMDLs for Total Dissolved Gas (TDG) and Temperature TMDLs on the Columbia/Snake River Mainstem under Clean Water Act section 303(d). EPA's roles can be broken down into three basic categories: technical analysis; issuing a federal TMDL; and approving/disapproving a state TMDL, described in the five efforts below:

- First, EPA will be taking action to approve /disapprove the Lower Columbia TDG TMDLs which will be issued by Oregon and Washington. The geographic scope is from the Pacific Ocean to the confluence with the Snake River;
- Second, EPA will be taking action to approve/disapprove the Lower Snake River Mainstem and Mid-Columbia River TDG TMDLs that will be prepared by the state of Washington;
- Third, EPA will be doing the technical analysis and issuing the TDG TMDL for Indian reservation waters in the Upper Columbia, including Lake Roosevelt;
- Fourth, at the request of the states of Oregon and Washington, EPA will be doing the technical analysis and issuing temperature TMDLs for the Columbia/Snake River Mainstem in Oregon and Washington; and
- Finally, for the portion of the Snake River Mainstem in Idaho, EPA will be doing the technical analysis for the temperature TMDL that will be issued by Idaho and submitted to EPA for approval.

More details on these five efforts can be found in the attached draft strategy document: "Strategy



for Consultation and Coordination with Indian Tribal Governments for Completing Columbia River and Snake River Mainstem TMDLs."

### **Need for Adequate Monitoring**

EPA agrees that good monitoring information is essential both to develop the TMDLs and to design and implement measures to achieve water quality standards. It is important to clarify that implementation activities are not within the scope of EPA's responsibilities in the TMDL effort. In other forums EPA has expressed continued concerns to the Federal Columbia River Power System Action Agencies (U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration) on the need for enhanced monitoring in the mainstem Columbia and Snake River. EPA provided the attached paper to the Corps in April 2001, "An Outline of a Monitoring Program for Estimating the State of Water Temperature in the Columbia and Snake River," with specific recommendations on improving monitoring. EPA is continuing to work with these federal agencies to address the recommended improvements, and we are interested in any support CRITFC or CRITFC tribes can provide in seeing these monitoring proposals implemented.

### **Critical System Configuration in Federal and Federal Energy Regulatory Commission (FERC) Licensed Dams**

As mentioned above, EPA does not have authority to include requirements within these TMDLs to implement system configuration changes. However, EPA's TMDL work effort will provide a critical foundation for future implementation decisions for federal and FERC dams. The temperature analysis being conducted by EPA as a part of the temperature TMDL effort will provide a temperature load allocation modeling which will form the basis for future decisions to reduce water temperature. This is a vital addition to state of the art knowledge of the temperature in the Columbia and Snake River system.

EPA will, through its other authorities and programs, continue to work with Federal and non-Federal agencies toward implementing water quality measures consistent with the Clean Water Act and the recent Biological Opinion. The major work effort for this is the development and implementation of the Water Quality Plan. The 2000 Federal Columbia River Power System (FCRPS) Biological Opinion called for the development of a systemwide Water Quality Plan for the mainstem Columbia/Snake River. The purpose of this Water Quality Plan is to move towards Clean Water Act standards attainment. The Water Quality Plan is intended to focus on the physical and operational changes to both Federal and non-Federal dams to improve water quality. It is our expectation that EPA discussions with the federal action agencies on the Water Quality Plan will identify measures to move toward standard attainment. We encourage any assistance or support from CRITFC and/or CRITFC tribes in the development and implementation of water quality improvement measures.

### **Mainstem TMDL Consultation and Coordination Efforts**

EPA recognizes its unique legal relationship with Tribal governments as set forth in the U.S. Constitution, treaties, statutes, executive orders, and court decisions. Federal policies instruct EPA to have regular and meaningful consultation with Indian Tribal governments when developing policies and regulatory decisions on matters affecting their communities and resources. EPA Region 10 has made specific commitments on how we will consult and coordinate with Indian tribal governments in the U. S. EPA Region 10 Tribal Consultation Framework, a copy of which is attached to this letter. EPA has the goal of trying to achieve consensus before a final EPA decision is made. It is our hope that the tribal coordination and consultation EPA is undertaking for its

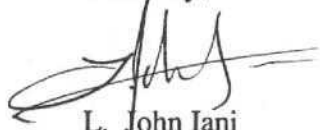


actions and decisions on the mainstem Columbia and Snake River TMDLs will build on our efforts to date.

A government-to-government dialogue with Columbia Basin Tribes and EPA was held on the TMDL work effort in Spokane, Washington, March 2000. Since that time, EPA has invited tribal staff to participate in monthly TMDL coordination meetings of the agency staffs who are working on the various TMDL efforts. EPA has provided a small grant to the National Fish and Wildlife Foundation to help support tribal coordination and consultation for the 14 Columbia Basin Tribes. This grant supported a meeting sponsored by CRITFC that was held on the Warm Springs Indian Reservation in September 2001. Other forums for tribal staff and tribal policy discussions are currently being planned with tribal staff input. Because these five TMDL efforts reach across three states, affect 14 tribes, and involve several federal agencies, EPA Region 10 would like to establish a specific plan to guide our consultation efforts in the future. We have prepared an initial draft strategy for distribution to the tribes, which we would like to use as a starting point for discussing an appropriate plan for involving the tribes. The views and perspectives of CRITFC and the CRITFC tribes on this strategy would very helpful.

In conclusion, EPA is committed to establish the appropriate dialogue and two-way communication with tribal governments on this Columbia River water quality improvement effort. If you have any further questions or concerns regarding the mainstem Columbia and Snake River TMDLs please do not hesitate to call me directly at (206) 553-1234 or Mary Lou Soscia at (503) 326-5873.

Sincerely,



L. John Iani  
Regional Administrator

Attachments:

1. Draft EPA Strategy for Consultation and Coordination with Indian Tribal Governments for Completing Mainstem Columbia River and Snake River TMDLs, January 2002.
2. U. S. Environmental Protection Agency- Region 10 Tribal Consultation Framework, July 16, 2001.
3. U.S. Environmental Protection Agency, Region 10 - "An Outline of a Monitoring Program for Estimating the State of Water Temperature in the Columbia and Snake River," April 2001.

Draft - January 13, 2002

**EPA STRATEGY FOR CONSULTATION AND COORDINATION WITH  
INDIAN TRIBAL GOVERNMENTS FOR COMPLETING  
MAINSTEM COLUMBIA RIVER AND SNAKE RIVER TMDLs**

- I. **Purpose of the Strategy** - This strategy describes EPA's strategy for consultation and coordination with Indian Tribal Governments on the EPA actions to be taken on the Mainstem Columbia/Snake River TMDL. As outlined in the July 2001, U.S. Environmental Protection Agency- Region 10 Tribal Consultation Framework (attached), EPA is committed to consult with federally recognized tribal governments in a manner respectful of tribal sovereignty and culture.
- II. **The Columbia/Snake River Mainstem TMDLs** - EPA Region 10 is working with the states of Idaho, Oregon, Washington, in coordination with the 14 Columbia Basin Tribes to develop Columbia and Snake River Mainstem TMDLs for dissolved gas and water temperature to meet state and tribal water quality standards. These Total Maximum Daily Loads will focus solely on loading allocations for dissolved gas and water temperature. Implementation activities to improve water quality are not within the scope of EPA's responsibilities in this TMDL effort.
  - A. **EPA Temperature TMDL for Washington and Oregon** At the request of the states of Oregon and Washington, EPA will be doing the technical analysis and issuing temperature TMDL's for the Columbia/Snake River Mainstem in Oregon and Washington.
  - B. **Idaho Temperature TMDL** - For the portion of the Snake River Mainstem in Idaho, EPA will be doing the technical analysis for the Temperature TMDL that will be issued by Idaho and submitted to EPA for approval.
  - C. **Oregon/Washington Lower Columbia Total Dissolved Gas TMDL** - EPA will be taking action to approve or disapprove the Lower Columbia Total Dissolved Gas TMDLs which will be issued by Oregon and Washington. The geographic scope is from the Pacific Ocean to the confluence with the Snake River.
  - D. **Washington Total Dissolved Gas TMDL** EPA also will be taking action to approve or disapprove the Lower Snake River Mainstem and Mid-Columbia River Total Dissolved Gas TMDLs that will prepared by the state of Washington.
  - E. **EPA Total Dissolved Gas TMDL for Colville and Spokane Reservations** - EPA will be doing the technical analysis and issuing the Total Dissolved Gas TMDL for Indian reservation waters in the Upper Columbia, including Lake Roosevelt.
- III. **Other EPA Activities in the Columbia/Snake River System** - EPA is addressing Columbia and Snake River water quality improvement implementation activities in other policy forums. For the mainstem Columbia/Snake River, EPA is engaged with the



Federal Columbia River Power System (FCRPS) action agencies - the U.S. Army Corps of Engineers, the Bonneville Power Administration, and the Bureau of Reclamation, in the development of a Columbia River Water Quality Plan. The Water Quality Plan was called for in the 2000 FCRPS Biological Opinion in Appendix B to address water quality actions needed for the Columbia but were considered outside the boundaries of species recovery. EPA is participating in other regional forums including the Federal Regional Executives, the NMFS Implementation Forum, and the Transboundary Gas Group to provide representation on Clean Water Act policy and technical decisions for the Columbia River.

IV. **Affected Tribal Governments** The following 14 Columbia Basin tribal governments are considered affected by the mainstem Columbia/Snake River TMDL:

Burns Paiute Tribe of the Burns Paiute Indian Colony of Oregon  
Coeur d'Alene Tribe of the Coeur D'Alene Reservation, Idaho  
Confederated Salish and Kootenai Tribes of the Flathead Reservation, Montana  
Confederated Tribes of the Colville Reservation, Washington  
Confederated Tribes of Grand Ronde  
Confederated Tribes of the Umatilla Indian Reservation, Oregon  
Confederated Tribes of the Warm Springs Reservation of Oregon  
Confederated Tribes and Bands of the Yakama Nation, Washington  
Kalispel Indian Community of the Kalispel Reservation, Washington  
Kootenai Tribe of Idaho  
Nez Perce Tribe, Idaho  
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho  
Shoshone-Paiute Tribes of the Duck Valley Reservation, Nevada  
Spokane Tribe of the Spokane Reservation, Washington

V. **General Approaches for Consultation and Coordination**

- A. Formal Government-to-Government Consultation with Tribal Governments - The Tribe may request formal consultation which may be conducted by the Regional Administrator or his designee.
- B. Coordination With Tribes, Their Staffs, and Regional Tribal Groups (CRITFC, UCUT, and Snake River Tribes - Monthly meetings are being conducted with EPA, state and tribal staff to discuss policy and technical decisions. In addition, EPA representatives are available to meet with tribal staff and policy representatives to discuss technical and policy issues.
- C. Coordination with States, Other Federal Agencies, and EPA - EPA and the states of Oregon, Washington and Idaho signed a Memorandum of Agreement to define roles and responsibilities for the development of the Mainstem TMDLs. For approximately one year, EPA has been coordinating monthly meetings between the states, tribal staff and other interested entities to coordinate TMDL development.
- D. Funding -Funding for individual tribal consultation and coordination is not available. However, EPA has provided a small grant to the National Fish and Wildlife Foundation to help support tribal coordination and consultation. This

grant supported a meeting held on the Confederated Tribes of the Warm Springs Indian Reservation in September 2001 which provided a forum to discuss the TMDL efforts and tribal issues. Other forums for tribal staff and tribal discussions are being planned right now. EPA is pursuing additional funding to support tribal consultation and coordination.

- E. Issue Resolution - EPA will work with tribal governments to develop a consensus decisions before a final EPA decision is made. The EPA action/decision for these TMDLs is the development and issuance of the loading allocation for the temperature TMDL; for tribal waters, the development and issuance of the loading allocation for the gas TMDL; and the approval of the loading allocation for the state developed gas TMDLs.

VI. **Agency Contacts and Information Sources**

Mary Lou Soscia, Columbia River Coordinator - (503) 326-5873

Richard Parkin, Temperature TMDL Senior Staff - (206) 553-8574

Dan Opalski, Director of the Oregon Operations Office - (503) 326-3250

Jim Werntz, Director of the Idaho Operations Office - (208) 378-5743

Tom Eaton, Director of the Washington Operations Office - (360) 753-8086



**U.S. ENVIRONMENTAL PROTECTION AGENCY- REGION 10  
TRIBAL CONSULTATION FRAMEWORK  
July 16, 2001**

**REGION 10 WORKING DEFINITION OF TRIBAL CONSULTATION**

**“Consultation” means the process of seeking, discussing, and considering the views of federally recognized tribal governments at the earliest time in EPA Regions 10's decision-making. Consultation generally means more than simply providing information about what the agency is planning to do and allowing comment. Rather, consultation means respectful, meaningful, and effective two-way communication that works toward a consensus reflecting the concerns of the affected federally recognized tribe(s) before EPA makes its decision or moves forward with its action.**

**REGION 10 GUIDING PRINCIPLES**

1. The Region will consult with federally recognized tribal governments in a sensitive manner respectful of tribal sovereignty and culture.
2. The Region will maintain government-to-government communications with federally recognized tribal governments by interacting through officials of appropriate stature and authority, and as determined by the Regional Administrator and tribal government. For major consultation issues, the time frame and manner in which EPA will consult with a specific Tribe will be negotiated between EPA and the Tribe.
3. In situations where EPA has the ultimate decision-making authority, federal policies direct EPA to consult with affected federally recognized tribal governments prior to decision-making. The Region will work within the following guidelines when deciding how to consult with federally recognized tribes:
  - ◆ When the matter may directly affect the environment, resources, treaty rights or other legal rights of a specific or small number of federally recognized tribes, EPA will meet with, have conference calls, and send letters to tribal leaders of the affected individual tribe(s). EPA will provide feedback as specifically requested by the Tribe(s) and take any agreed upon follow-up action on the matter in a timely manner;
  - ◆ When seeking perspectives from all interested federally recognized tribes in the Region on national or broad Regional issues, EPA will meet with, or have a conference call, or solicit written views in a letter from EPA;
  - ◆ When looking for broad guidance on tribal policy or implementation matters of national or Regional interest either at a preliminary stage or requiring fast turn-around, EPA will rely on the Regional Tribal Operations Committee for assistance and input. This dialogue will not replace the government-to-government relationship and communication between EPA and the Tribe(s);

4. On specific matters, the Region should contact and provide any available materials necessary to the potentially affected federally recognized tribes as early as practicable, to provide time for consultation prior to making a decision.
5. Where feasible and appropriate, the Region will encourage regular participation of federally recognized elected tribal representatives or their designees on Regional planning and work groups.
6. The Region will directly notify federally recognized tribe(s) where specific tribal interest or trust resources may be involved, and offer the respective tribe(s) an opportunity to participate without resolving whether the tribe(s) has a legal right to consultation.
7. The Region will meet with individual federally recognized tribes upon request of the tribe's leaders.
8. The Region should endeavor to build an on-going relationship with federally recognized tribal government(s) to increase communication, and to ensure that consultation on specific proposals will be more constructive and effective.
9. The Region will encourage meetings with federally recognized tribal governments on their homelands, to the extent resources allow, to strengthen the EPA federal-tribal relationship and facilitate EPA understanding of respective tribal issues, concerns and perspectives.
10. Public participation which involves individual citizens of Indian Country, is not the same as consultation with affected federally recognized tribal governments. EPA has the responsibility to consult with federally recognized tribal governments separate from, and in addition to, the public participation process for interested stakeholders.
11. Consultation with tribal governments should occur independent of the public participation process. Tribal consultation does not replace requirements to promote public participation that may apply to a given proposed federal action.

#### **ISSUE RESOLUTION**

Should disputes arise between one or more tribes and EPA Region 10, the parties will strive to address the matter informally, at the staff level. In the event that staff are unable to resolve a dispute, the issue will be presented to immediate supervisors, who will attempt to resolve the dispute. If the dispute is not resolved, the staffs will present the matter to progressively higher levels of management until consensus is reached. In the event consensus is not reached, the EPA Regional Administrator, after consulting with the elected leader(s) of the federally recognized Tribe(s), will make the final decision.



April 25, 2001

An Outline of a Monitoring Program for Estimating the State of Water Temperature  
In the Columbia and Snake Rivers

John Yearsley  
EPA Region 10  
Seattle, Washington

The importance of water temperature for the Columbia River ecosystem has been the topic of scientific analysis and discussion for several decades. The work of Raphael (1962), for example, represents one of the first efforts to apply the energy budget method to a major river system. A workshop convened in 1963 by the Federal Water Pollution Control Commission represented an early effort on the part of regional scientists to discuss biological, physical and chemical effects of water temperature. Davidson (1964) analyzed long term records of the Columbia River for purposes of characterizing the effects of Wells, Rocky Reach, Wanapum and Priest Rapids dams on the temperature of the Columbia River. Davidson (1964) also observed that storage of deep water in Arrow Lake in Canada was a potential source of cold water for a period of 30 to 50 days in the summer. Studies by Battelle (Jaske and Synoground, 1970), under contract to the Atomic Energy Commission (AEC), described the impacts of Grand Coulee Dam and Lake Roosevelt on the temperature regime of the Columbia and also demonstrated the potential for using releases of cold water from Grand Coulee for downstream temperature control.

The Columbia River Thermal Effects Study was initiated by the Department of Interior in January 1968 to develop consistent water quality standards for the states of Oregon and Washington. The study was motivated by the sense that upriver runs of Columbia River fish had been reduced and endangered by the physical alteration and blockage of migration routes by the nation's largest system of dams and reservoirs, and that Columbia River temperatures had been both spatially and temporally altered by man's activities. The research conducted during the study contributed to much of our existing knowledge of temperature effects on Pacific salmon. In addition, the study produced a working mathematical model of water temperature of the Columbia River from the International Border to its mouth near Astoria, Oregon.

The agencies that operate the dams on the Columbia and Snake rivers showed little interest in the results of these studies until recently, when several *Ecologically Significant Units* were listed as threatened or endangered under the Endangered Species Act, and segments of both rivers were listed as water-quality limited for temperature under Section 303 of the Clean Water Act. This lack of interest is reflected in the state of the temperature monitoring programs on the Columbia and Snake rivers. Prior to 1984, measurements of water temperature in Columbia and Snake consisted of manual observations of temperature from thermometers placed in the cooling water stream of each dam's turbines. These observations, generally described as scroll case measurements were made on a daily basis by dam operations personnel. A recent evaluation of these measurements (Cope, 2001) found many deficiencies in the instruments, in the location of the instruments and the protocols for collecting and reporting data. Many of these deficiencies



appeared to be related to the original motivation for installing the thermometers, which was for purposes of monitoring the operation of turbines rather than for analyzing temperature effects on Pacific salmon.

Temperature monitoring associated with the total dissolved gas program was initiated in 1984 at many of the dams. In contrast to the scroll case temperature monitoring program, the focus of the total dissolved gas monitoring was on characterizing the state of water temperature in the rivers rather than on monitoring the operation of machinery in the project. Nevertheless, the resulting data, as compiled by McKenzie and Laenen (1998) and reported on the Columbia River Web site for Data Access in Real Time (DART) site shows a lack of attention to quality control. One also has the feeling that the temperature measurements are primarily an adjunct to the total dissolved gas monitoring rather than an effort to adequately estimate the state of water temperature in the Columbia and Snake rivers. A sample of 29 year-long records on the Columbia River (Columbia River at International Boundary, Columbia River at Grand Coulee) and the Snake River (Ice Harbor Dam forebay and tailrace, Little Goose Dam forebay and tailrace) found that 14 of the records had either large gaps of missing data or large portions of data that were clearly erroneous. Figure 1 is an example of data that are clearly erroneous.

It has become clear that sound scientific methods for estimating the state of water temperature in the Columbia and Snake rivers are needed to address issues of endangered species and failure to meet water quality standards of the states of Idaho, Oregon and Washington. Two essential elements of any monitoring program, elements that are not present in the existing program on the Columbia and Snake rivers, are a clearly defined set of objectives and a well-designed quality assurance/quality control plan. The objective of the monitoring program described below is to obtain adequate state estimates of water temperature in the Columbia and Snake rivers for purposes of developing a Total Maximum Daily Load (TMDL) as required by Section 303 of the Clean Water Act. EPA can also provide technical assistance for development of an adequate quality assurance/quality control plan. The plan of action for dissolved gas monitoring (February 2001) contains many of the concepts that would be needed for an adequate river temperature monitoring program (as noted above, the dissolved gas plan treated water temperature measurements as an adjunct to the total dissolved gas program).

A monitoring program that meets the objectives of developing a temperature TMDL for the Columbia and Snake rivers should include the components described below. This level of monitoring should be conducted for a period of at least five years. After five years, the plan should be revised and modified based on reduced uncertainty in model estimation parameters.

#### Flow

Daily river flow measurements are required for the main stem Snake and Columbia and for major tributaries. Measurements of river flows, as presently conducted and reported by the USGS, provide an adequate network of data and meet standards of quality control/quality assurance.

#### Temperature

Water temperature measurements are required at existing total dissolved gas monitoring sites. Additional spatial coverage should be provided at all the total dissolved gas tailrace sites (or at a separate location such as a bridge crossing) that would provide the capability for characterizing



the cross-sectional average of water temperature. A minimum design at these sites would be a total of nine locations configured as three equally-spaced moorings across the width of the river, with three temperature probes per mooring at approximately equally-spaced intervals in the vertical. In addition, single, continuous temperature monitoring sites should be located at the mouth of major tributaries including the Kettle River, Colville River, Spokane River, Yakima River, Salmon River, Grande Ronde River and the Clearwater River at Orofino. Weekly observations at smaller tributaries, as described in Yearsley (1999), are needed for the period April-October. Monthly observations in these tributaries are sufficient during the remainder of the year. Particular attention should be given to quality assurance/quality control at all temperature monitoring sites.

#### Reservoir Elevation

Reservoir elevation measurements are required at all locations presently reported on the Columbia River DART. Particular attention should be given to improving these measurements at Grand Coulee and Dworshak dams, where small errors in the measurement of surface elevation introduce significant error into the water budgets.

#### Reservoir Operation

Measurements of flow from the various hydroelectric operations are required at all projects. This includes the flow through all turbines, spillway and outlet facilities. These measurements are particularly important at Grand Coulee and Dworshak, where vertical stratification plays an important role in the downstream temperature regime.

#### River Geometry

Adequate river geometry (river cross-sections in HEC-2 format) are required at approximately one-mile intervals throughout the main stem Snake and Columbia rivers.

#### Meteorology

An adequate network of weather observations is an essential component of this monitoring program. Weather stations that measure and record wind speed, air temperature, and moisture content (dew point, relative humidity, or wet bulb) should be sited at each hydroelectric project. Cloud cover can be observed at regional sites including the existing first-order stations maintained by the Weather Service. In addition, the U.S. Bureau of Reclamation AGRIMET sites should be modified to include cloud cover measurements.

References

- Cope, B. 2001. Site Visits to Six Dams on the Columbia and Snake Rivers, EPA Region 10, Memorandum to the files dated 4/18/2001.
- Davidson, F.A. 1964. The temperature regime of the Columbia River from Priest Rapids, Washington to the Arrow Lakes in British Columbia. *Prepared for the Public Utility District No. 2 of Grant County, Ephrata, Washington.* 31 pp. + tables and figures
- Jaske, R.T. and M.O. Synoground. 1970. Effect of Hanford plant operations on the temperature of the Columbia River 1964 to present. *BNWL-1345.* Battelle Northwest, Richland, Washington.
- McKenzie, S.W. and A. Laenen. 1998. Assembly and data-quality review of available continuous water temperatures for the main stems of the lower- and mid-Columbia and lower-Snake rivers and mouths of major contributing tributaries. NPPC Contract C98-002, Northwest Power Planning Council, Portland, Oregon.
- Raphael, J.M. 1962. Prediction of temperature in rivers and reservoirs. *J. of the Power Div. Am. Soc. Civ. Eng.*, PO 2, pp. 157-181.
- Yearsley, J.R. 1999. Columbia River Temperature Assessment – Simulation Methods. EPA Region 10, Seattle, Washington. 388 pp. + appendices.



**Figure 1. Water temperature at CIBW  
as reported on the DART Site**

